



COMPUTED TOMOGRAPHY (CT) SCANNING FOR PETROPHYSICAL APPLICATIONS

Background

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Traditional core evaluation techniques evaluate the minerals from exterior properties until all testing is concluded and the rocks can be sectioned and observed by a microscope. For real time evaluations or in situ observation, an alternative is to use X-rays to see inside the cores. A good technique to observe the actual progression of fluids (movement) inside rocks is to use computer tomography scanning (CT scanning) at successive time intervals to record the displacement or flooding process. Since the CT scanner procedure uses 3-D coordinates that do not change unless the sample is removed from the instrument, changes in the conditions of each 3-D "voxel" can be recorded versus time. The "slices" can be reconstructed to provide 3-D images of scanned objects seen from many perspectives.

Sometimes minerals have interactions with fluids that are inside them. Though mechanisms and causes are not completely known, it is well established experimentally that coal reacts with both methane and CO₂ to alter the nature of some of the minerals. It has been observed that coal swells upon adsorption of CO₂. Loss of permeability from coal swelling is a serious issue in carbon sequestration in unminable coal seams. In situations where the desire is to use CO₂ to displace coal-bed methane, significant complications may arise due to the shrinking/swelling interactions.

Regardless of which in situ processes are under consideration, it is necessary to evaluate the suitability of the selected site (site characterization) for application of the process. One of the techniques used to characterize the internal reactions/behavior of coal with CO₂ is dual energy CT scanning. The core is scanned at two different (high and low) X-ray tube voltages. By comparing these scans to known standards, changes in effective atomic number can be determined. Knowing that simultaneous changes in density (from CT number) and atomic number (dual energy results) occur, important and necessary information is made available for every internal voxel to simulate numerical efforts. Since it is possible to simultaneously vary experimental simulations of in situ stresses on the cores and fluid pressures, site characterization is greatly enhanced.

For evaluation of carbon sequestration in inert rocks (such as displacement of brine from sandstone), or oil/gas production by displacement (e.g. waterflood), real time in situ progress of fluid displacement can be observed. Since the voxels are all recorded in a 3-D coordinate system, quantitative, volumetric and linear measurements are all available for retrieval by using the software.



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Primary Project Goal

To evaluate target carbon sequestration or hydrocarbon production cores from in situ real time perspectives. This will allow for the possibility of more accurate numerical simulations and economic evaluations., as well as enhancing the assessments of project feasibility.

Objectives

The CT scanner test results on coal will be used in conjunction with results from the Geologic Sequestration Flow Lab (GSCFL) at NETL to help determine behavior of coal when CO₂ is injected into deep coal seams for geologic sequestration of CO₂. These data will be used to assist computer simulations of CO₂ injection and development of coal swelling models for realistic evaluation of technical/economic feasibility of CO₂ sequestration in coal seams. In addition, the CT scanner will obtain real-time in situ images in a sandstone core of CO₂ injection from full brine saturation till CO₂ breakthrough. These data will assist computer simulation efforts of CO₂ sequestration in brine saturated sandstone formations.

The CT scanner will be used to observe CO₂ injection in a brine saturate mineral core (sandstone, carbonate, etc.) to aid numerical simulation efforts. Fingering, high permeability strata, and core anomalies can be discerned in situ while they are progressing. In addition, the CT scanner will do research complementary to the GSCFL project in NETL/PGH. Testing of identical cores in both labs will allow us to evaluate the cores in a more complete manner.

Accomplishments

Coal is being scanned at dual energy to evaluate coal/CO₂ interactions at varying pore fluid and confining pressures.

Benefits

Mineral cores can be evaluated at realistic confining pressures while simultaneously observing in situ changes in pore fluids and mineral densities/effective molecular weights. This information is essential to realistic numerical simulation, economic evaluations, and site characterization efforts.

